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Value-added Decking and Cladding – A Case Study of the Swedish Market

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Abstract

The range of value added decking and cladding products currently available on the Swedish market is probably greater than ever. Although, there are also both opportunities and threats for further development in this industry sector, the extant research has not addressed this topic. The present paper fills this gap through conducting a qualitative exploratory case study undertaken to describe the structure and macro factors influencing the industry. The study integrates PESTEL (Political, Economic, Social, Technological, Environmental and Legal) framework with Porter's Five Forces of Competitive Position. Data for the PESTEL analysis were collected from industry experts and triangulated through secondary sources. Data for the Five Forces analysis were collected through qualitative interviews. The findings indicate that PESTEL factors have neutral or positive influences on the industry, while the Five Forces analysis indicates that the strength of buyers' power and threats from substitutes may pose future challenges. Furthermore, the findings indicate that the industry has potential for further growth and warrants attention from various players that are not yet involved.

Keywords: Decking products, Swedish market, Porter's Five Forces, PESTEL, Value-added

1.0 Introduction

Changes including population increases, poverty, urbanization, globalization, climate change and over-exploitation of finite resources are posing major global challenges (UNESCO, 2010; Worldbank, 2015). Thus, it is increasingly essential to develop and sustainably use renewable resources, such as wood, which have played a key role in human survival for millennia and is probably used more widely than ever as fuel and raw material for both traditional and modern products (e.g. textiles).

Wood has several advantageous properties, such as high strength to weight ratios, and easiness to process, shape and join (Saarman, 1992). However, it also has some disadvantages, notably susceptibility to humidity-mediated dimensional changes, biodegradation, and weathering in external environments (Hill, 2006). These susceptibilities have been intensively researched, and various strategies to reduce them have been developed (Hill, 2006; Rowell, 2006c). The most widely used technique to prevent biodegradation is treatment with wood preservatives. In the EU roughly 6.5 million m^3 of timber products are annually treated with preservatives (Salminen et al., 2014). Of this, approximately 1.5 million m^3 is treated in Sweden (NTR, 2015), which equals about 8 % of the annual Swedish sawn timber production volume that currently stands at 16 million m^3. However, use of wood preservatives has been subject to increasing restrictions and regulations (Preston, 2000). For instance, the commonly applied preservative CCA (copper, chrome and arsenic) was prohibited in Sweden in 1994 (Larsson-Brelid et al., 2011), in the EU in 2004 (Commission Directive, 2003), and is no longer allowed for residential use in the USA (Rowell, 2013). Hence, there are both limitations and opportunities for product innovation, not only to protect wood from biodegradation but also to enhance other properties.

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The timber industry is gradually moving away from the traditional commodity view (Hugosson & McCluskey, 2009), and there are a substantial body of innovation-related research in the forest sector conducted from 2000 (Hansen et al., 2014). However, there is limited forest sector literature on new product development despite that the field is widely covered in general literature (Hansen et al., 2014). Thus, new product development particularly requires further analysis, partly because the lack of research attention and partly because product development is highly important for a company to be competitive and create a positive self-image (Stendahl et al., 2006). Furthermore, during the last two decades diverse kinds of new forest products have emerged, including wood that been modified thermally, chemically, or by impregnation (Hill, 2011) and the North American decking industry has seen a growth and dramatic change in types of decking materials (Eastin et al., 2005). Accordingly, in the Swedish decking market (the focus of the present study) there are now probably more commercial alternatives to traditional pressure-treated pine products than before. These include (*inter alia*) acetylated wood, thermally modified wood, furfurylated wood, silicon-modified wood, Royal-treated wood, and wood-plastic composites (WPC), in addition to natural durable species as larch, and tropical hardwoods.

Some of the technologies and alternative durable species used to produce these materials are not new, for example Tiemann (1915) reported effects of heat treatment, while Fuchs (1928), Horn (1928) and Suida and Titsch (1928) all reported effects of acetylation. Since then there has been substantial further technological development, some of it based on the early work by Stamm and co-workers in the 1930s-50s at the Forest Products Research Laboratory in Madison, Wisconsin, USA (Hill, 2006). Among other options, the potential of numerous reagents to enhance wood through chemical modification has been tested during the last century. However, most commercial developments have occurred in the last decade, particularly in Europe (Hill, 2011), and Militz and Lande (2009) concluded that many challenges must be overcome when bringing new technologies and new wood products to the market.

The decking material segment has previously been explored in various studies e.g. customer value (Holopainen et al., 2014), perception and preference studies of treated wood in US (Vlosky & Shupe, 2002, 2004a, 2004c, 2005), and perceptions of decking materials in Scandinavia (Nyrud & Hölbö, 2008; Nyrud et al., 2008; Riala, et al., 2013; Roos & Nyrud, 2008a, 2008c). Further, studies have explored decking advertisement (Hamner et al., 2012; McGraw et al., 2015) and the willingness to pay for natural durable wood products (Donovan & Hesseln, 2004). Other studies have considered certain aspects of the decking sector from a market perspective, e.g. characterization of the U.S residential market (Shook & Eastin, 2001), status and future perspectives of the Chinese treated wood market (Cao et al., 2011), assessment of market potential for Alaska Yellow cedar (Eastin et al., 2005), position and market analysis of the US decking materials market (Ganguly et al., 2011), and trends in the US market (Ganguly & Eastin, 2009). Notably, majority of these studies have examined the US market and the European (particularly Scandinavian) decking market has received much less attention.

As the decking industry grows, so does the need for applied economic research. Thus, various studies have considered certain aspect of the sector from a market perspective e.g. assessing acceptability parameters for chemical modified timber decking (Killerby et al., 2007a), present and future aspects of chemical modified timber decking (Killerby et al., 2007b), the commercialization and production of modified wood in Portugal (Esteves et al., 2014), commercialization development of modified wood (Jones, 2007), and modified wood production and markets in Russia (Kiseleva et al., 2015). Some have also considered the commercialized technologies, e.g. Homan and Jorissen (2004), Hill (2006), Hill (2011), and Rowell (2013) (Rowell, 2006a). Others have described current production status or general experiences, although many such papers have focused on the technologies *per se*, e.g. Franich (2007), Ala-Viikari (2007), and Kattenbroek (2007). Brynildsen and Myhre (2007) described external market factors and purchasing criteria influencing the business, particularly regarding furfurylated wood. Roos et al., (2002) noted (based on previous authors' findings) that for success an industry needs to adapt products to meet the market needs, and a market orientation is required to improve wood industries' profitability.

Individual firms competing within the industry often have considerable insights regarding their markets. However, despite the abundant research on technological and economic aspects of this industry, few studies have addressed the competitive forces within an industry

and external factors that may influence it. Thus, further research is required to improve understanding of the industry and the key factors and competitive forces affecting it. Accordingly, the aim of this study is to characterise the industry's market situation, in Sweden, by addressing the following research questions:

i. What macro factors may affect the industry, and what are their likely effects?
ii. What are the industry's structural characteristics?

The study focuses on industry actors producing timber products enhanced by modification or impregnation for decking or cladding applications (excluding products pressure-treated with creosote, solvent-based reagents and water-borne copper-based preservatives) for (*inter alia)* the Swedish market. The products included are acetylated, thermally modified, furfurylated, silicon-treated, and Royal process-treated wood (including copper, but is a two-step process). The products can be used for several applications but in this study decking and partly cladding applications are emphasized.

First, the conceptual framework for the study is developed, consisting of the six sets of PESTEL (political, economic, social, technological, environmental and legal) external macro factors and the Five Forces of Competitive Position proposed by Porter (1980). The framework is then applied in a case study of the Swedish market. An overall qualitative approach is adopted. Results are then presented in relation to the conceptual framework, and finally the findings are discussed.

2.0 Framework for the Study

2.1 The Framework

As mentioned above, the theoretical framework consists of PESTEL macro factors potentially affecting any industry and the Five Forces identified by Porter (1980) as shaping an industry's structure: the rivalry among competitors, the horizontal power of suppliers and buyers, and vertical threats from new entrants and substitutes. This section describes these two sets of components and their integration as the overall theoretical framework for this study, as illustrated in Figure 1.

2.2 PESTEL Factors

Any industry may be affected by a vast numbers of factors, which can be divided according to Grant (2008) into "source" factors (political, economic, social and technological) and "proximity" factors (internal for a firm or sector). The four sets of source macro factors are included in an integrated model of marketing planning, developed at the University of Helsinki and applied in several forest product-related scientific publications (Hansen & Juslin, 2005). In some conceptual frameworks the four sets are complemented with environmental and legal factors, resulting in the acronym PESTEL. Both of these sets of factors appear to be highly relevant for the focal industry, thus they were included in the framework. As noted by Bovaird and Löffler (2009), no PESTEL analysis can be fully comprehensive, it is only possible to consider broad effects of some of the main factors of each category that may influence an industry (as listed in Table 1). PESTEL factors are included here since they may substantially impact the focal industry, while it may be difficult for the industry to influence them.

2.3 Porter's Five Forces

The second part of the theoretical framework in this study, the Five Forces model proposed by Porter (1980), which previous forest sector studies have applied generally (Gold et al., 2005; Husso & Nybakk, 2010) but

Table 1. Examples of PESTEL factors and those considered in the study.

Macro Factors	Examples	Considered in the study
Political	Public opinion Political views of governing parties Lobbying efforts by interest groups	Political views of governing parties
Economic	GDP Interest rates Spending patterns	Interest rates
Social	Income distribution Population distribution Culture and values	Culture and values
Technological	Patents R&D	R&D
Environmental	Climate Pollution Sustainability	Climate Sustainability
Legal	Laws Regulations Public policy	Laws Regulations Public policy

also specifically in studies involving decking products (Hamner et al., 2012) and modified wood (Kiseleva et al., 2015). The strengths of these forces (rivalry among competitors, horizontal powers of suppliers and buyers, and the vertical threats from new entrants and substitutes) can be used to define an industry's structure and the competition within it (Porter, 1980). Despite its wide recognition and application, the model has received both criticism and suggestions for development (Porter, 2008). Grant (2008) suggested inclusion of a sixth force, which he called the complement force. This refers to a product or service that is used together with an industry's products and increases the value of the industry's products when it is available. Thus, the supplier of a complement product has substantial bargaining power (Grant, 2008). However, Porter (2008) perceived this conceptual construct as a factor rather than a force. Grundy (2006) noted three limitations of Porter's framework: excessive attention to industry-level phenomena, oversimplification of industries' value chains, and apparent independence of the model from other parameters.

Prahalad and Ramaswamy (2000) describe an evolution in perceptions of the role of customers, from passive buyers in the 1970s-90s (when Porter published his framework) towards their current role as collaborators, co-developers and competitors. Furthermore, they claim that there is a transformation from clearly defined formal roles that customers are changing the marketplace, and that firms' communication with their customers is becoming a dialogue between equals. Although these changes diverge from Porter's framework for analysing industries in current settings, the model is still widely used. In addition, Dobbs (2014) has developed a set of operationalization templates based on Porter's five forces, which is also applied here.

2.4 Integrated Framework

In accordance with proposals by Grundy (2006), Porter's five forces model was combined with the PESTEL factors in the theoretical framework to consider broad macro factors influencing the industry in addition to sectoral forces (Figure 1). The division seems logical, because it can be very difficult for a single actor or even an industry to influence PESTEL factors, while decisions and actions of a single actor can influence Porter's Five Forces more easily, especially in a small, niched industry such as the one considered in this paper.

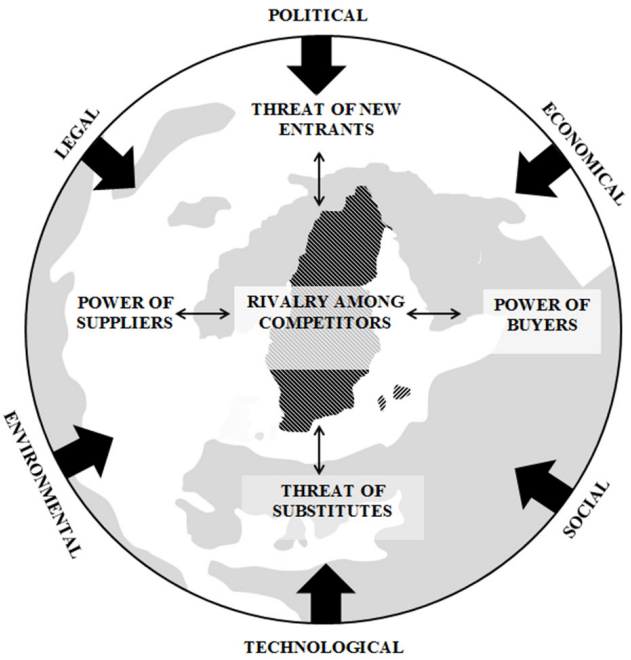

Figure 1. Schematic illustration of the conceptual framework applied in this study, consisting of the Five Forces model (Porter, 1980) and PESTEL macro factors.

3.0 Data and Methods

This section includes a description of the research methodology adapted, the sampling strategy used, the data collection approach and finally the analysis approach of the study is presented.

To investigate the current situation of the Swedish value added decking and cladding products market a qualitative approach (Creswell, 2014) was adopted, focusing on companies using the five non-traditional technologies. Case studies are particularly suitable for in-depth exploratory analyses of a particular sector or situation, enable the researcher to take a holistic view (Denscombe, 2014), and have been previously used in industry structure analyses (Yin, 2009).

3.1 Sample

Two separate sampling strategies were used to select respondents for the PESTEL analysis and the Five Forces analysis. For the PESTEL analysis, industry experts (e.g. representatives from universities, institutes, industry organisations, companies etc.) were selected using a snowball sampling, i.e. one industry expert refers to other industry experts (Atkinson & Flint, 2001). All experts had relevant knowledge of the studied market, the industry and its development.

The participants in the Five Forces analysis, were selected by purposive sampling, i.e., the firms were chosen to cover producers of the range of relevant products available on the Swedish market, while their representatives were hand-picked due to their experience of the topic and their relevant and privileged knowledge. Thus, they formed an exploratory rather than a representative sample (Denscombe, 2014). The interviewees were representatives of five companies, each supplying the Swedish market (inter alia) with products generated using one of the technologies covered in the study, and one representing several producers associated with one specific technology. The majority of these producers are not integrated with sawmills and they all have manufacturing operations in Europe.

3.2 Data Collection

Data for the PESTEL analysis was collected by conducting interviews with industry experts. These interviews were conducted between February and June 2015, and triangulated with data from secondary sources, such as scientific papers, electronic sources, news articles and reports. Notes from interviews as well data from secondary sources were saved digitally for the analysis.

Data for Porter's five force analysis was collected through six in-depth interviews conducted from March to June 2015. The interviews were semi-structured using a questionnaire based (with slight modifications) on the templates presented by Dobbs (2014), which provide interviewees opportunities to indicate the strength of threats or forces on an incremental scale from low to high, in addition to making comments related to each question. The questionnaires were sent to the interviewees prior to the interview. The interviews were tape recorded when possible, but for some only field notes were taken because of noisy surroundings. The interviews were transcribed and interviewees were invited to approve the transcripts (none of the interviewees refused). The interviews lasted between one to three hours and were face-to-face, except the one that was conducted over the phone. In one of the interview sessions two interviewees were present; but all other interview sessions had one interviewee each (Table 2). Total six interview sessions were conducted.

3.3 Analysis

In this study the data from industry experts and the secondary sources as well as the transcripts from the six interviews were categorised in broad nodes and sequentially analysed accordingly to the theoretical framework, e.g. the six sets of macro factors (see Table 1) and the Five Forces, using Nvivo computer-assisted qualitative data analysis software.

Table 2. Respondent firms (A-F), numbers of interviewees attending each interview, and applications of their products (decking and/or cladding)

Respondent firm	Number of interviewees	Applications
A	2	Decking & Cladding
B	1	Decking & Cladding
C	1	Decking & Cladding
D	1	Decking & Cladding
E	1	Decking & Cladding
F	1	Decking

The categorised data was then further divided into sub-nodes and analysed in more detail to distinguish condensed themes and both similarities and differences in the data. In addition to the analysis of the data from the six interviews, the Five Forces incremental scale in the questionnaire was divided into four equal sections (low, moderately low, moderately high and high) in order to categorize and summarize responses.

4.0 Results

This section first presents the summarized results in the integrated framework, see Figure 2, then following the partitioning of the theoretical framework, the results from the PESTEL analysis (as summarized in Table 3), and finally the results from the interviews in terms of Porter's Five Forces (as summarized in Table 4).

4.1 PESTEL Factors

4.1.1 Political Factor

The following three main political factors were distinguished. Firstly, the Swedish government has 16 environmental quality objectives, one of which is "a non-toxic environment" (i.e. to ensure that all parts of the environment in Sweden are non-toxic or, more strictly, free of anthropogenic toxins). As a step towards achieving this objective, recommendations are previously made that include additional taxes on some consumer products containing potentially hazardous chemicals. Also costs of

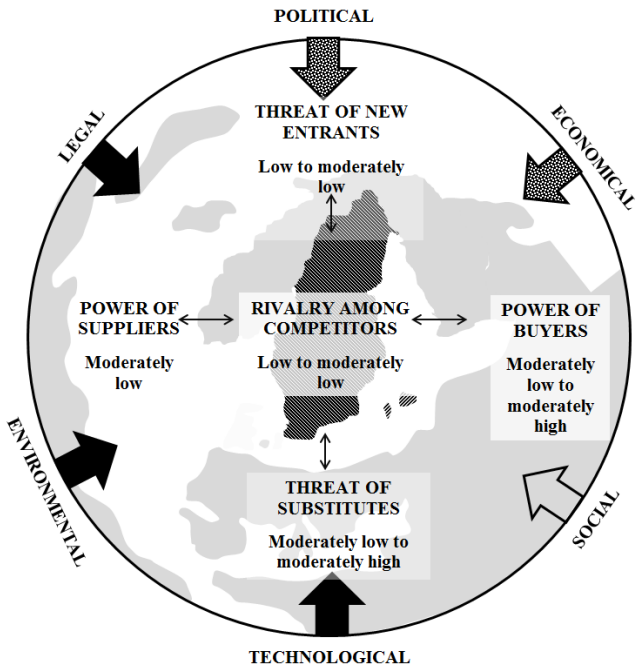

Figure 2. Assessed impacts of the PESTEL factors (indicated by solid arrows if positive, open arrows if neutral, and stippled arrows if neutral or positive) and reported strengths of the Five Forces (as described in Table 4).

Table 3. The macro factors included in the conceptual framework and their assessed impact on the studied industry.

Factor categories	Factors included	Assessed impact on the industry
Political	Political view of governing parties	Positive or neutral
Economic	Interest rates	Positive or neutral
Social	Culture and values	Neutral
Technological	R&D	Positive
Environmental	Climate Sustainability	Positive
Legal	Laws Regulation Public policy	Positive

building repairs, conversions and extensions have been tax deductible in Sweden since 2004, but the level of deductions are reduced from 2016. Thirdly, the European Commission has initiated a review of the best available techniques (BAT) reference document regarding wood preservation with chemicals (Commission, 2016).

4.1.2 Economic Factors

From 2015-01-18 to date there has been a negative repurchase agreement rate in Sweden, for the first time, due to low inflation. This has led to generally low interest rates for both consumers and companies, prompting increases in consumption and investments. During the last five years annual sales of Swedish building merchants and hardware merchants have increased significantly, notably sales increased by 12.3 % during 2015. These observations indicate that political and economic factors have a positive or neutral overall impact on the focal industry.

4.1.3 Social Factors

Sweden has a long tradition of using wood in diverse applications. However, softwoods are mainly used, which may potentially limit the market for suppliers of products intended to be substitutes for tropical hardwoods. Nevertheless, social factors are assessed as having a neutral impact on the industry due to the high general approval for the use of wood.

4.1.4 Technological Factors

There is some research and development activity related to the studied industry at several universities and one institute in Sweden. A result of this activity is the patented and now commercially available product Organowood, invented by researchers at Stockholm University and the Swedish University of Agricultural

Table 4. Results from the interviews regarding Porter's Five Forces, their strengths and brief explanations of the interviewees' perceptions (rationale).

Force	Perceived strength	Rationale
Rivalry among competitors	Low to moderately low	Other actors in the studied industry are not perceived as competitors
Power of suppliers	Moderately low	There are many potential timber suppliers, but slightly fewer fulfil requirements
Power of buyers	Moderately low to moderately high	Awareness of these products has been low but is now increasing
Threat from new entrants	Low to moderately low	The respondents want their own business to grow but have non-hostile attitudes to new entrants
Threats from substitutes	Moderately low to moderately high	Perceptions of substitutes, from pressure-treated wood to fibre-reinforced concrete, vary widely

Sciences. However, it was reported repeatedly that the Swedish research on methods to improve wood's durability is decreasing. Furthermore, the market is global and innovations from other countries will reach Sweden eventually (and vice versa) hence the technological factors probably have a positive impact on the industry because if wood's disadvantages can be overcome, its renewability and carbon-neutrality could give it a very strong market position relative to alternative materials.

4.1.5 Environmental Factors

The Eurobarometer (2011) indicates that Swedes are more concerned about the climate and environmental issues than the average European citizen. The forest area in Europe and Asia is increasing, but decreasing in the rest of the world. In Sweden the standing forest volume is also increasing. In addition, the Eurobarometer (2011) reported that 89 % of Swedes claimed they were willing to pay a little more for environmentally friendly products, a higher share than in any of the 27 countries surveyed. For these reasons environmental factors are assessed as having a positive impact on the studied industry as its products are made from sustainable resources.

4.1.6 Legal Factors

The traditional wood preservative (pressure-treated) industry has been subject to both specific legislation, such as the prohibition of CCA in 2004, and general industrial laws, such as national, EU and global requirements for safe waste disposal. Another legal factor that affects the industry is public policy since (for instance) several municipalities, e.g. Sundbyberg, just outside Stockholm, recommend avoiding use of pressure-treated wood in kindergartens (Sundbyberg, 2015). Similar policies have been imposed elsewhere in Sweden, and/or advocated in media articles on pressure-treated wood. However, legal factors may have a positive impact on the studied industry if the competing products or substitutes are subject to stricter regulations.

4.2 The Five Forces

The results from the interviews regarding Porter's Five Forces are summarized in Table 4 and described in more detail in the following text.

4.2.1 Rivalry among Competitors

Generally, the interviewees' comments indicate that they did not perceive the other actors in the studied industry as competitors, partly at least because they perceived distinct differences in each other's products in terms of features, properties, price and (hence) both applications and customer segments. This is illustrated by the following comment from interviewee A: "*comparing wood against wood there's a big difference between the products, but naturally not as big as between wood and steel*". Some of the interviewees perceived pressure-treated wood as a competitor due to its large market share and low price as a decking product. Naturally durable species, such as cedar, tropical hardwood and larch were also repeatedly mentioned as competing wood products, and other cellulose-containing products, such as wood plastic composites (WPC), as additional main competitors. These products are considerably more expensive than pressure-treated wood (although their prices vary substantially), but several of the interviewees mentioned that this was a factor of decreasing importance. Overall, their comments indicate that investments in the technologies they apply are increasing and overall their sector is growing (although not necessarily the respondent companies). The findings indicate that rivalry among the studied actors is low to moderately low.

4.2.2 Power of Suppliers

The findings clearly indicate that the number of timber suppliers considerably exceeds the number of chemical suppliers. The technologies used by the respondents' companies differ, and their needs for chemicals or other equipment vary accordingly, but often there are relatively few suppliers of these resources in relation to the number of timber suppliers. This indicates that the timber suppliers have less power than other suppliers. Thus, discussion about the power of suppliers is mainly based on the timber suppliers, but partly because all the companies need timber. The findings suggest, unsurprisingly, that there are vast numbers of potential timber suppliers, but far fewer practical options. Several interviewees mentioned difficulties in having quality discussions with their timber suppliers, e.g. "*The understanding of our needs as customers varies between suppliers*" (interviewee B) and "*It has been, and is, quite difficult to get the suppliers' attention regarding the timber quality we need*" (interviewee F). The timber species used are mainly Scots pine (*Pinus sylvestris)* and Monterey pine (*P. radiata)*. The interviewees regarded suppliers' opportunities for forward vertical integration

as ranging from impossible to fairly likely, but the interest is perceived as increasing. Overall, the findings indicate that the power of suppliers is moderately low.

4.2.3 Power of Buyers

Responses regarding the power of buyers indicate that sales and numbers of customers are rising, as is customers' awareness of the existence of the niched products (albeit from a low level), as expressed by interviewee D: *"I think the general awareness has been very low but the situation is continuously improving"*. Typical buyers are described as the specifiers or architects who decide what materials will be used in certain projects, particularly where price is not a major priority and the specifier is looking for something distinctive. End customers are also not concerned primarily about price and want something different from traditional or ordinary products, according to participants who target end consumers. Several interviewees noted that environmental aspects are considered more by specifiers than end customers. The interviewees perceived little likelihood for buyers to pursue backward integration. Overall, the findings indicate that the power of buyers is moderately low to moderately high.

4.2.4 Threats from New Entrants

When discussing the threat from new entrants the interviewees expressed a desire for their own business to develop and expand. However, they also perceived benefits of an increased number of actors due to the accompanying increases in opportunities for joint lobbying efforts, marketing and market processing to increase awareness of the industry. As interviewee C commented: *"If a new actor wants to invest in a plant, we can help each other to increase the market for our products, we are colleagues rather than competitors"*. Several of the interviewees reported that any future legislation most likely would have a positive impact on the industry. The capital requirements needed for entering this industry vary, depending on the technologies applied, and for some there are patent restrictions while others are more accessible. The findings indicate that the threat from new entrants is perceived as low to moderately low.

Several interviewees reported that the Swedish market differs from others, remarking (for example): *"Sweden is a market that has not yet decided where to go, it has a little bit of everything"* (interviewee B), and "*Other markets are more willing to try new products"* (interviewee A). This is interesting as pre-painted cladding products have been highly successful in the Swedish market.

4.2.5 Threat from Substitutes

The respondents' perceptions of both substitutes and the threats they pose varied substantially, precluding any general description. The main substitutes mentioned by some were materials such as concrete or fibre-reinforced cement for cladding applications, while others largely mentioned WPC and tropical hardwood. However, several of the respondents perceived the industry's products as substitutes for untreated wood, pressure-treated wood, and tropical hardwoods. Due to the variations in their perceptions of substitutes, they perceived their own products as being cheaper than substitutes in some cases, and more expensive in others. Similarly, they perceived the performance of substitutes as being slightly better than that of their industry's products in some cases, and slightly worse in others. Overall the findings indicate that the threat from substitutes is moderately low to moderately high.

5.0 Discussion

The results from this study indicate that the external PESTEL factors have neutral or positive influences on the industry. They also indicate that three of Porter's Five Forces (rivalry among competitors, power of suppliers, and the threat of new entrants) have low to moderately low strength, while the other two (power of buyers and threat from substitutes) have moderately low to moderately high strength. The findings are discussed in more detail in this section.

5.1 PESTEL Factors

Generally, economic factors (notably low interest rates and construction tax deductions) may have a positive impact on the industry by promoting increases in investments and consumption. Repair and replacement by homeowners has previously been pointed out as an important driver for the demand of decking materials (Eastin et al., 2005; Ganguly et al., 2010). However, such effects should apply to most industries rather than being unique to the focal industry. The introduction of the government's objective to ensure that the Swedish environment is non-toxic and the associated inquiry have not directly affected the studied industry or the wood preservative (pressure-treated) industry as yet, but may in the future due to the chemical agents involved.

Similarly, revisions to the EU Best available techniques reference document regarding wood preservation with chemicals may have consequences for some actors in the industry that cannot yet be reliably predicted.

Several interviewees perceived pressure-treated wood as a substitute and/or its producers as competitors. Hence any factors that have a negative impact on the pressure-treated wood industry should increase opportunities for the focal industry to gain market share. Such factors could include further legislation, changes in public opinion and policy changes resulting in taxes on pressure-treated wood, subsidies for the studied products, or recommendations to use solid wood products without any toxic agents. Notably, if public policies like the one adopted in Sundbyberg become more common, interest in products such as those considered here will likely increase.

Lundmark et al. (2014) reported benefits of using solid wood products in terms of optimizing the Swedish CO_2 balance, which could also promote a positive perception of solid wood products. However, in some parts of the world the forest area is decreasing, which (together with ongoing concern and debate regarding biodiversity) may lead to a negative perception of the use of solid wood generally. The sustainability aspect is highlighted in the marketing material of the studied products, which is an important message to send, particularly to the environmentally conscious Swedish population. However, it is not clear whether the studied products are perceived as more environmentally friendly than the competing products or substitutes. Furthermore, Hansen and Juslin (2005) stress the importance of avoiding over-emphasizing environmental aspects of products derived from the forest industry meaning that environmental aspect is added on top of the basic attributes of a forest related product.

Sometimes actors in the modified wood sector (not necessarily those considered here) market their products as substitutes for tropical hardwood. For such companies, markets with a history of using tropical hardwoods may be more relevant targets than markets with a strong softwood heritage, like the Swedish market. However, significantly penetrating the market in Sweden may be challenging due to the strong position of pressure-treated wood products (unless, as mentioned, public policy or legislative changes intervene). Overall the macro factors are assessed as having either no or a positive impact on the industry, and hence being unlikely to hinder future expansion. This is in line with previous studies e.g., Kiseleva et al. (2015) which conclude that thermally modified timber is growing and has potential for further growth. Also Brynildsen and Myhre (2007) conclude that external market trends (in combination with the products properties) indicates a promising future for the industry. However, if this currently small industry expands, it might attract attention from not yet considered agents.

5.2 The Five Forces

The actors in this industry are generally small companies that do not own sawmills, and focus on this very specific segment of the value-added wooden product sector. Some larger sawmill-owning companies beyond the geographic scope of this study apply some of the relevant technologies, but the rivalry among competitors is reportedly low to moderately low.

Porter (1980) proposes that if rivalry is high, competition is usually expressed through price, service or marketing. Furthermore, he notes that price competition generally leads to reductions in profitability for all of the actors in an industry, while marketing competition often has a positive impact on the industry by fostering increases in demand. Hence, when the industry expands, actors within it should ideally compete through marketing rather than price wars, and hence at least potentially increase demand for the whole industry. This possibility was implicitly acknowledged by the interviewees, who reported that marketing was one way to increase customers' awareness of their products.

Since the rivalry among the competitors is reportedly low there may be opportunities for joint lobbying and communication efforts to increase overall awareness of the industry. Jones (2007) also notes that potential business benefits can be gained by working together with other actors within the industry. Actors who exploit a technology applied by several producers reported that pressure on prices has increased, but this is not yet a major issue. The rivalry will most likely increase when the industry expands, but if the actors focus on competing through marketing rather than price the whole industry can potentially gain (while the pressure-treated wood industry provides an example of price competition resulting in low profitability). Generally, the respondents did not perceive each other as competitors, probably at least partly because this is still a small industry and each

actor contributes to establishing and increasing general awareness of the products. This might also explain why the industry perceives stronger competition from other materials, i.e. treated wood and natural durable wood species (both tropical and non-tropical), and non-wooden materials, such as fibre-reinforced concrete (for products used in cladding applications). Hence the challenge is to gain market shares from other industries. Jones (2007) proposes that the industry should address non-wood material markets thus these are the competing materials.

The price range of the studied products varies considerably, but can be roughly divided into two benchmarking price segments: one in the range of larch and one in the range of tropical hardwoods. The enhanced properties also vary between the products. Lack of perceived rivalry may indicate that actors within the studied industry have found strategic niches, and hence do not perceive each other as competitors. This is supported by Jones (2007) mentioning that some technologies are targeting specific product segments.

The interviewees regarded the power of suppliers as moderately low. High power of suppliers can result in increased prices, or reductions in either service or quality (Porter, 1980). The interviewees did not report any price or service issues, but mentioned a lack of quality discussions with their suppliers. However, the relations with the material supplier are important (Brynildsen & Myhre, 2007). As this industry is relatively small it is surprising that the suppliers' power is not considered stronger, but this might be due to the large number of timber suppliers. Furthermore, if the industry keeps growing the power of suppliers may decrease even further, because its value for the suppliers will increase.

The interviewees' perceptions of the power of buyers varied from moderately low to moderately high. If the power of buyers is high, they can bargain on price or demand better service and/or quality (Porter, 1980). The interviewees did not mention any quality or service issues, but reported that price was of decreasing importance. Overall, their main reported concern was low general awareness of their products among potential customers. As noted by Brynildsen and Myhre (2007) there is no use in having premium products if the customers are unaware of them, although they notice an increased awareness of the industry's products. The awareness might rise if the industry expands, and further rises can be promoted through increased marketing-based competition and joint marketing efforts. In addition, the Nordic Wood Preservation Council recently decided to extend their classification scheme to include a class for modified wood. As the classification scheme is widely known, this may help to increase awareness of modified wood and assist comparisons of the products by end customers. However, it is not clear if actors in the modified wood sector are interested in this development.

The threat from new entrants is low to moderately low according to the interviewees. A new entrant brings new capacity to the industry and might use price pressure to gain market share, thereby affecting the incumbents' profitability (Porter, 1980). However, the threat from new entrants depends on the entry barriers and incumbents' responses (ibid). It is also influenced by technological factors since there are three main ways to enter a market: inventing a new technology, buying a license to apply a patented technology, or investing in a technology that is no longer patented. The first option is difficult in the focal sector, as enhancing the durability of wood or other attributes requires expensive, long-term investments. The second option may also be challenging as the incumbents have opportunities to decide if, who and where a new actor may enter the industry. The third option might be the easiest, but raises risks of price competition, and it may be difficult to compete with incumbents using newer patented or licensed technology.

In any industry, as the price/performance ratio of substitutes increases they increasingly limit the potential profitability for incumbents (Porter, 1980). The interviewees' responses indicate that the threat from substitutes is moderately low to moderately high in the focal sector, but there were considerable variations in their expressed perceptions of substitutes. This variation may be related to variations in the actors' niches, as some (for example) focus on traditional wood distribution channels while others target specifiers. Some may also be related to variations in the actors' target applications. Several interviewees mentioned WPC as a substitute or competitor. However, WPC products have gained higher market shares in decking applications (and thus may pose greater threats) in markets in other countries. As some of the reported substitutes are WPC and fibre-reinforced concrete, they pose challenges not only for the focal industry but for solid wood product industries in general.

5.3 General Opportunities and Challenges

Two notable features of the studied sector are that the actors, generally, do not originate from sawmilling industries, and Swedish sawmilling companies have not yet shown any interest in it. However, the Swedish pine sawmills could potentially counter the strong perceived power of buyers as they have well established distribution channels and strong customer relations. They could also address quality issues relatively easily, through internal communication channels. Thus, the focal sector may provide attractive opportunities that very few Swedish pine sawmill companies have considered as yet, despite the value of product innovation noted by authors such as Stendahl et al. (2006).

Furthermore, the interviewees perceive a general reluctance for the Swedish market to try new products. This may be at least partly due to the strong presence and history of pressure-treated wood (which may also explain why some interviewees perceived pressure-treated wood as a substitute or competitor). Approximately 8% of the annual volume of timber produced in Sweden is pressure-treated, and some of the largest sawmilling companies participate in this activity. Thus, the sawmilling companies may be focusing on their pressure-treated timber production and may not yet have seen the potential of the studied industry. However, pre-painted cladding is regarded as a new product with rapidly growing market shares. Thus, it seems possible to introduce new products to the Swedish market successfully.

This study should be viewed as a preliminary exploration of the possibilities and constraints of this emerging industry. Further, although the participants cover at least most of the range of applied technologies, the results should be interpreted and generalized very cautiously due to the small, purposively selected sample. In addition, as a case study the recorded opinions can only reflect the situation when the interviews were conducted and will most likely change over time (Denscombe, 2014), especially as this is an small but emerging industry. The method, combining external factors and internal forces, has proven to be useful to illuminate an industry. This was expected since the combination were proposed to reduce the independence between the five forces and other parameters (Grundy, 2006) and they have previously been combined e.g. Kiseleva et al. (2015).

Since the respondents did not perceive the other actors in the studied industry as competitors the study may not have been optimally delimited and a broader perspective (including pressure-treated timber, larch wood and WPC for example) may have been beneficial, at least for probing the competitive environment. However, the primary objective was to obtain perceptions and opinions of actors in the defined industry. The results may also reflect a general issue regarding Porter's Five Forces: difficulties for respondents to define and identify competitors and substitutes. Analyses based on the five forces and the questionnaire created by Dobbs (2014) can provide a comprehensive view of an industry's structure, but the terminology might be too formal, resulting in a need for explanations in some cases.

Historically, there have been several attempts to commercialize wood modification technologies, some of which are still being used while others are not. It would be valuable to identify the factors contributory for past successes and failures in further studies, to increase chances of future success. The power of buyers was perceived as moderately high, so the customers' perceptions of value also warrant future academic consideration.

The findings reveals that external factors are expected to have limited restraints on the industry, hence unlikely to hinder future growth. However, they are complex and difficult to predict, therefore the assessment should be cautiously interpreted. Despite the complexity and challenge for an industry to influence external macro factors they can potentially be influenced proactively. Therefore, the industry can address relevant macro factors (e.g. political and environmental) and work proactively through joint lobbying efforts and cooperation with counterparties to promote and develop sustainable bio-products. The analysis of the industry structure indicates that the power of buyers and threat from substitutes will pose challenges. Accordingly, it's relevant for the industry to consider and manage both external factors as well as the internal forces. The overall findings indicate that the industry has potential for further growth and warrants attention from various players that are not yet involved.

Due to the author's employment as an industrial PhD student at one of the larger forest industry companies in Sweden ethical aspects of the study also need to be addressed. All participants in the study were clearly informed about the employment of the author, and in all email correspondence the corporate email address has been used instead of a university address to avoid

any uncertainties. It should also be noted that (as in any study) participants' responses may have been incomplete, skewed, biased or self-censored (Creswell, 2014), despite attempts to minimize such problems by ensuring anonymity and asking broad questions about the industry rather than specific questions about customers and production costs etc. that might stoke bias.

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